Title of the internship :

Density dependence and density independence in the demography and body size of experimental medaka populations

Supervisors :
Eric Edeline, Tel : 02 23 48 55 23, Email : eric.edeline@inra.fr
Etienne Rivot, Tel : 01 69 82 37 65, Email : etienne.rivot@agrocampus-ouest.fr

Institute:
UMR Ecologie et Santé des Ecosystèmes, 65 rue de Saint-Brieuc, Bât. 15, 35042 Rennes Cedex, France.

Summary (up to 300 words) :

Context

Quantifying the effects of density-dependent and density-independent factors in demographic and life-history processes remains a major challenge in population ecology and fisheries management (Turchin 1995, Stenseth et al. 2002, Myers 2008, Szuwalski et al. 2014). Here, we propose to use data from a long-term fishery experiment on medaka fish (*Oryzias latipes*) to investigate the respective contributions of density and climate to variations in reproduction, survival and body size.

Methods

The methods are based on fitting a stage-structured population dynamics model to 7-year data on abundance and body size for 12 independent pond populations of medaka (Bouffet-Halle et al. 2019). From 2012 to 2018 (7 years), each population was sampled for medaka number and individual body size in Mars and November (98% catch rate, 30975 body lengths). In March, 6 of the 12 populations were exploited for large-bodied individuals to simulate a fishery that produced a large contrast in population density (79% removal rate). We have developed a Bayesian Gaussian mixture model to estimate the proportion of juveniles and adults from size distributions (Bouffet-Halle et al. 2019). Technically, the work will consist in appending a population dynamics module (and potentially also a somatic growth module) to this Gaussian mixture model in order to estimate density- and temperature-dependency of (i) recruitment, (ii) adult summer survival, (iii) juvenile and adult winter survival, and (iv) juvenile and adult body sizes. The approach will further allow us to test for trends in residual body sizes that could reveal and evolutionary response to size-selective fishing.

Practical

The data and the Gaussian mixture model are readily available at ESE. The modeling will be implemented in a Bayesian state-space framework using JAGS or another language (Parent and Rivot 2012). The student will be based at ESE. Dates are from January to June 2020. Gratification according to INRA rules.

Other information :

Insertion within an ongoing research project (yes/no) :
Yes. This modeling internship is a follow-up of a research project currently involving two research teams in France (ESE and EGCE at Gif s/Yvette) and two research teams in Norway (CEES at University of Oslo, and the Weltzien group at the Norwegian University for Life Sciences).

Publications on the field of research (up to 3) :

Bouffet-Halle, A., J. Mériguet, D. Carmignac, S. Agostini, A. Millot, S. Perret, E. Motard, B. Decenciere, and E. Edeline. 2019. Density-dependent selection mediates harvest-induced evolution. BioRxiv:561522.

Turchin, P. 1995. Population regulation: old arguments and a new synthesis. Pages 19–40 in N. Cappuccino and P. W. Price, editors. Population Dynamics. First edition. Academic Press,

San Diego.

Parent, E. and Rivot, E. 2012. Introduction to hierarchical Bayesian modeling for ecological data. - Chapman and Hall/CRC.

References

Bouffet-Halle, A., J. Mériguet, D. Carmignac, S. Agostini, A. Millot, S. Perret, E. Motard, B. Decenciere, and E. Edeline. 2019. Density-dependent selection mediates harvest-induced evolution. bioRxiv:561522.

Myers, R. A. 2008. Recruitment: understanding density-dependence in fish populations. Pages 123–148 Handbook of Fish Biology and Fisheries. Blackwell Publishing Ltd.

Parent, E., and E. Rivot. 2012. Introduction to hierarchical Bayesian modeling for ecological data. First edition. Chapman and Hall/CRC, Boca Raton.

Stenseth, N. Chr., A. Mysterud, G. Ottersen, J. W. Hurrel, K. S. Chan, and M. Lima. 2002. Ecological effects of climate fluctuations. Science 297:1292–1296.

Szuwalski, C. S., K. A. Vert-Pre, A. E. Punt, T. A. Branch, and R. Hilborn. 2014. Examining common assumptions about recruitment: a meta-analysis of recruitment dynamics for worldwide marine fisheries. Fish and Fisheries 16:633–648.

Turchin, P. 1995. Population regulation: old arguments and a new synthesis. Pages 19–40 *in* N. Cappuccino and P. W. Price, editors. Population Dynamics. First edition. Academic Press, San Diego.